

PRACTICE PAPERS CHEMISTRY OLYMPIADS

STAGE – 1

Paper – 10

TIME: 1HR 30MIN

MAX MARKS: 180

- Attempt all the Questions.
- All questions carry +3 for right answer and -1 for wrong answer.
- Use of Calculator is allowed.

PERIODIC TABLE OF THE ELEMENTS

1 1A												18 8A							
1 H 1.008	2 He 4.003											3 Li 6.941	4 Be 9.012	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95		
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80		
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3		
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)		
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)		

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Name:

Correct Questions =

Wrong Questions =

Unattempt Questions =

Marks =

1. Which salt is colorless?
 (A) KMnO_4 (B) BaSO_4
 (C) Na_2CrO_4 (D) CoCl_2
2. Which 0.10 M aqueous solution exhibits the lowest electrical conductivity?
 (A) NH_4Cl (B) CuBr_2
 (C) Na_2CO_3 (D) $\text{C}_2\text{H}_5\text{OH}$
3. Which element is a liquid at 25°C and 1 atm?
 (A) fluorine (B) chlorine
 (C) bromine (D) iodine
4. Mixing which combination produces a gaseous product?
 (A) solid ammonium nitrate and solid calcium hydroxide
 (B) copper metal and 0.10 M hydrochloric acid
 (C) solutions of barium hydroxide and 0.10 M sulfuric acid
 (D) solutions of aluminum nitrate and sodium chloride
5. Which technique can be used to determine the number of components in a plant pigment?
 (A) calorimetry (B) chromatography
 (C) colorimetry (D) gravimetry
6. In the determination of the molar mass of a solid acid by titrating it with a standardized base, which procedural error will yield a molar mass that is smaller than the actual value?
 (A) adding the standardized base to a buret containing drops of water
 (B) dissolving the weighed solid acid in twice the recommended volume of water
 (C) using half as many drops of indicator as suggested
 (D) weighing out half of the recommended mass of solid acid
7. The mass of one atom of an element is 1.71×10^{-22} g. What is the atomic mass of this element in $\text{g}\cdot\text{mol}^{-1}$?
 (A) 101 (B) 103 (C) 105 (D) 107
8. What is the percent by mass of nitrogen in ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3$?
 (A) 14.53% (B) 27.83%
 (C) 29.16% (D) 33.34%
9. How many moles of water will be produced from the complete combustion of 4.4 g of C_3H_8 ?
 (A) 0.10 (B) 0.25 (C) 0.40 (D) 0.80
10. A 10.0 g sample of an oxide of copper forms metallic copper and 1.26 g of water when heated in a stream of hydrogen. What is the mass percent of copper in this oxide?
 (A) 11.2% (B) 66.6% (C) 79.9% (D) 88.8%
11. A 49.9 g sample of barium hydroxide octahydrate, $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$, is dissolved in water and the solution is diluted to give a final volume of 2.50 L. What is the concentration of the hydroxide ion in this solution?
 (A) 0.0634 M (B) 0.127 M
 (C) 0.190 M (D) 0.634 M
- | Molar Mass / $\text{g}\cdot\text{mol}^{-1}$ | |
|--|-----|
| $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ | 315 |
12. What volume (in mL) of 0.0500 M phosphoric acid is needed to titrate completely 25.0 mL of 0.150 M barium hydroxide solution to a phenolphthalein end point?
 $3\text{Ba}(\text{OH})_2 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Ba}_3(\text{PO}_4)_2 + 6\text{H}_2\text{O}$
 (A) 50.0 (B) 75.0 (C) 100. (D) 150.
13. A sample of gas at 273 K has a pressure of P_1 and a volume of V_1 . When the pressure is changed to P_2 , what is the volume V_2 ? (Assume the temperature remains constant.)
 (A) $\frac{P_1 P_2}{V_1}$ (B) $\frac{P_1 V_1}{P_2}$
 (C) $\frac{P_2 V_1}{P_1}$ (D) $\frac{P_2}{P_1 V_1}$

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€

€

14. How do the number of molecules, n , in 1.0 L of each of the following gases; CH_4 , N_2 , CO_2 , compare at 1 atm and 25°C ?

- (A) $n_{\text{CH}_4} < n_{\text{CO}_2} < n_{\text{N}_2}$ (B) $n_{\text{N}_2} < n_{\text{CO}_2} < n_{\text{CH}_4}$
 (C) $n_{\text{CO}_2} < n_{\text{CH}_4} < n_{\text{N}_2}$ (D) $n_{\text{CH}_4} = n_{\text{CO}_2} = n_{\text{N}_2}$

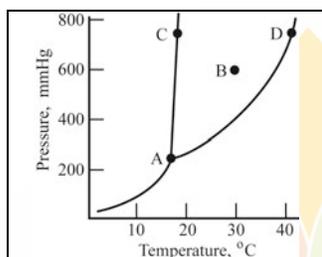
15. Solid sodium acetate, $\text{NaC}_2\text{H}_3\text{O}_2$, is what type of solid?

- (A) ionic (B) metallic
 (C) molecular (D) network covalent

16. Which substance has the highest vapor pressure at 25°C ?

- (A) methanol, CH_3OH
 (B) ethanol, $\text{CH}_3\text{CH}_2\text{OH}$
 (C) 1-propanol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
 (D) 1-butanol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

17. Which point on the phase diagram represents the normal boiling point?



- (A) point A (B) point B
 (C) point C (D) point D

18. What types of intermolecular forces are exerted by CH_3Cl molecules in the liquid phase?

- I. dipole-dipole forces
 II. hydrogen bonding
 III. London dispersion forces

- (A) I only (B) II only
 (C) I and III only (D) II and III only

19. A 22.0 g piece of metal is heated to 100.0°C and placed in 75.0 g H_2O at 25.0°C . If the final temperature of the metal and water is 27.8°C , what is the specific heat capacity of the metal in $\text{J}\cdot\text{g}^{-1}\cdot^\circ\text{C}^{-1}$? (Assume no heat is lost/gained by the surroundings.)

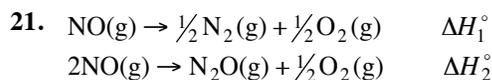
$C_p / \text{J}\cdot\text{g}^{-1}\cdot^\circ\text{C}^{-1}$
H_2O 4.18

- (A) 0.038 (B) 0.16 (C) 0.55 (D) 5.0

20. Which change(s) is(are) accompanied by an increase in entropy of the system?

- I. conversion of $\text{O}_2(\text{g})$ to $\text{O}_3(\text{g})$
 II. freezing of water
 III. sublimation of iodine

- (A) I only (B) III only
 (C) I and II only (D) II and III only



Which relationship is correct?

- (A) $\Delta H_1^\circ = \Delta H_2^\circ$
 (B) ΔH_f° for $\text{NO}(\text{g}) = \Delta H_1^\circ$
 (C) ΔH_f° for $\text{N}_2\text{O}(\text{g}) = \Delta H_2^\circ$
 (D) ΔH_f° for $\text{N}_2\text{O}(\text{g}) = \Delta H_2^\circ - 2\Delta H_1^\circ$

22. When 2.74 g of $\text{Ba}(\text{s})$ reacts with $\text{O}_2(\text{g})$ at 298 K and 1 atm to form $\text{BaO}(\text{s})$, 11,100 J of heat is released. What is ΔH_f° for $\text{BaO}(\text{s})$ in $\text{kJ}\cdot\text{mol}^{-1}$?

- (A) 556 (B) 221 (C) -221 (D) -556

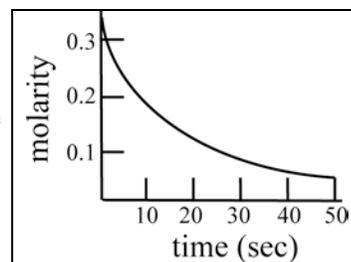
23. A reaction has $\Delta H^\circ > 0$ and $\Delta G^\circ > 0$ at 25°C . This reaction

- (A) is at equilibrium at 25°C .
 (B) could not be spontaneous under standard conditions at any temperature.
 (C) could be spontaneous under standard conditions at temperatures above 25°C .
 (D) could be spontaneous under standard conditions at temperatures below 25°C .

24. An ionic compound has a solubility of $1 \text{ mol}\cdot\text{L}^{-1}$ in water at 25°C and its solubility increases as the temperature is raised. What are the signs of ΔH° and ΔS° for the dissolving process?

- | | ΔH° | ΔS° |
|-----|------------------|------------------|
| (A) | + | + |
| (B) | + | - |
| (C) | - | + |
| (D) | - | - |

25. For the reaction represented by the accompanying diagram, which reaction rate is the greatest?



- (A) average rate (B) final rate
 (C) initial rate (D) rate at 20 seconds

26. Which units are appropriate for a reaction rate?

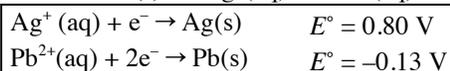
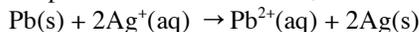
- (A) $\text{mol}\cdot\text{L}^{-1}\cdot\text{s}^{-1}$ (B) $\text{mol}\cdot\text{L}^{-1}$
 (C) $\text{mol}\cdot\text{L}\cdot\text{s}^{-1}$ (D) $\text{L}\cdot\text{mol}^{-1}\cdot\text{s}^{-1}$

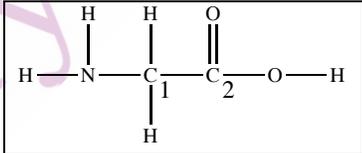
27. What is the rate equation for a reaction, $A + B \rightarrow \text{products}$, based on the rate data?

[A] ₀ , mol·L ⁻¹	[B] ₀ , mol·L ⁻¹	Rate
0.15	0.10	x
0.30	0.20	4x
0.30	0.40	16x

- (A) Rate = $k[A]^2$ (B) Rate = $k[B]^2$
 (C) Rate = $k[A][B]$ (D) Rate = $k[A][B]^2$
28. The effect of temperature on the rates of chemical reactions is primarily a result of the
- (A) size of the colliding molecules.
 (B) orientation of the colliding molecules.
 (C) enthalpies of the reactants and products.
 (D) kinetic energies of the colliding molecules.
29. The value of the rate constant for a gas phase reaction can be changed by increasing the
- (A) amount of product.
 (B) pressure of the reactant.
 (C) temperature of the reaction vessel.
 (D) volume of the reaction vessel.
30. What is the half life of the irreversible first order reaction, $A \rightarrow B$, if 75% of A is converted to B in 60 minutes?
- (A) 30 minutes (B) 45 minutes
 (C) 60 minutes (D) 80 minutes
31. What is the K_{eq} expression for the reaction, $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$?
- (A) $K_{eq} = \frac{2[CO]}{[CO_2]}$ (B) $K_{eq} = \frac{2[C][CO]}{[CO_2]}$
 (C) $K_{eq} = \frac{[CO]^2}{[CO_2]}$ (D) $K_{eq} = \frac{[C][CO]^2}{[CO_2]}$
32. The equilibrium system $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ has $K_p = 11$ and $\Delta H^\circ = 57 \text{ kJ}\cdot\text{mol}^{-1}$ at 25 °C. Which action will **not** cause a change in the position of the equilibrium?
- (A) increasing the temperature
 (B) adding $NO_2(g)$
 (C) adding xenon gas to increase the pressure
 (D) increasing the container volume
33. Which is not a conjugate acid/base pair?
- (A) H_2CO_3 & CO_3^{2-} (B) HSO_4^- & SO_4^{2-}
 (C) $H_2PO_4^-$ & HPO_4^{2-} (D) H_3O^+ & H_2O
34. What is the $[OH^-]$ in an aqueous solution which has a pH = 11.70?
- (A) $7.1 \times 10^{-2} \text{ M}$ (B) $5.0 \times 10^{-3} \text{ M}$
 (C) $1.4 \times 10^{-6} \text{ M}$ (D) $2.0 \times 10^{-12} \text{ M}$
35. Equal volumes of 0.25 M HNO_2 and 0.25 M HNO_3 are titrated separately with 0.25 M KOH. Which would be the same for both titrations?
- (A) initial pH
 (B) pH halfway to the equivalence point
 (C) pH at the equivalence point
 (D) pH when 5 mL excess KOH has been added
36. For which salt is the molar solubility, s, equal to $4 \times 10^{-6} \text{ M}$?
- (A) $AgC_2H_3O_2$ $K_{sp} = 2 \times 10^{-3}$
 (B) $TlBr$ $K_{sp} = 4 \times 10^{-6}$
 (C) $MnCO_3$ $K_{sp} = 2 \times 10^{-11}$
 (D) $Zn(OH)_2$ $K_{sp} = 3 \times 10^{-17}$
37. Which substance can act only as a reducing agent?
- (A) I_2 (B) $BrCl$ (C) $NaBr$ (D) HIO_4
38. When the equation $Sn^{2+}(aq) + IO_3^-(aq) + H^+(aq) \rightarrow Sn^{4+}(aq) + I_2(aq) + H_2O(l)$ is balanced, what is the $Sn^{2+}(aq) / IO_3^-(aq)$ mole ratio?
- (A) 1 / 1 (B) 2 / 1 (C) 1 / 2 (D) 5 / 2
39. Given the standard reduction potentials, which statement is correct?
- | | |
|--|-----------------------------|
| $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ | $E^\circ = 0.34 \text{ V}$ |
| $2H^+(aq) + 2e^- \rightarrow H_2(g)$ | $E^\circ = 0.00 \text{ V}$ |
| $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$ | $E^\circ = -0.73 \text{ V}$ |
- (A) $Cr(s)$ will react with acid.
 (B) $Cu(s)$ will react with acid.
 (C) $Cu^{2+}(aq)$ will react with acid.
 (D) $Cu(s)$ will react with $Cr^{3+}(aq)$.

40. Use the standard reduction potentials given to calculate the standard potential for the reaction;

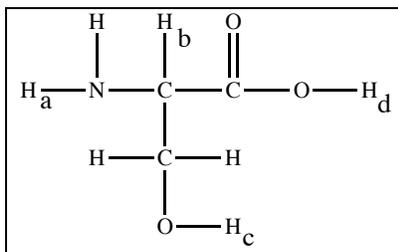


- (A) 1.73 V (B) 0.93 V (C) 0.67V (D) 0.54 V
41. For the voltaic cell represented,
 $\text{Ni(s)} \mid \text{Ni}^{2+}(\text{aq}) \parallel \text{Ag}^+(\text{aq}) \mid \text{Ag(s)}$
 which change will increase the cell potential?
 (A) increasing the $[\text{Ag}^+]$ (B) increasing the $[\text{Ni}^{2+}]$
 (C) adding Ni(s) (D) removing Ag(s)
42. The deposition of 1.0 g of which element from its molten chloride requires the shortest time at a current of 1 A?
 (A) Na (B) Mg (C) Al (D) Ba
43. Which properties of electromagnetic radiation are inversely related?
 (A) amplitude and frequency
 (B) energy and wavelength
 (C) energy and frequency
 (D) wavelength and amplitude
44. Which electronic transition in a hydrogen atom releases the greatest amount of energy?
 (A) $n = 3 \rightarrow n = 2$ (B) $n = 5 \rightarrow n = 3$
 (C) $n = 6 \rightarrow n = 5$ (D) $n = 3 \rightarrow n = 6$
45. Which must represent an atom in an excited state?
 (A) $1s^2 2s^2 2p^1$ (B) $1s^2 2s^2 2p^2$
 (C) $1s^2 2s^2 2p^3 3s^1$ (D) $1s^2 2s^2 2p^5$
46. Which quantum numbers represent the orbitals being filled in the ground state for the elements Sc (21) to Zn (30)?
 (A) $n = 3, l = 1$ (B) $n = 3, l = 2$
 (C) $n = 4, l = 1$ (D) $n = 4, l = 2$
47. Which pair consists of species that are isoelectronic?
 (A) Na^+, K^+ (B) Cl, Cl^-
 (C) $\text{Fe}^{2+}, \text{Mn}^{2+}$ (D) $\text{Ar}, \text{Ca}^{2+}$
48. In which series are the species listed in order of increasing size?
 (A) N, O, F (B) Na, Mg, K
 (C) Cr, Cr^{2+} , Cr^{3+} (D) Cl, Cl^- , S^{2-}
49. In which molecule does the chlorine have the most positive partial charge?
 (A) HCl (B) BrCl (C) OCl_2 (D) SCl_2
50. Which molecule contains the shortest carbon-carbon bonds?
 (A) C_2H_2 (B) C_2H_4 (C) C_3H_8 (D) C_6H_{12}
51. How many valence electrons are in one ion of thiosulfate, $\text{S}_2\text{O}_3^{2-}$?
 (A) 26 (B) 28 (C) 30 (D) 32
52. Which substance has the highest melting point?
 (A) CO (B) CO_2 (C) SiO_2 (D) P_2O_5
53. Which species has exactly five pairs of electrons around the central atom?
 (A) ClF_5 (B) SF_4 (C) SF_5^- (D) XeF_4
54. What are the hybridizations of the carbon atoms labeled C_1 and C_2 , respectively, in glycine?

 (A) sp^2 sp^2
 (B) sp^2 sp^3
 (C) sp^3 sp^2
 (D) sp^3 sp^3
55. The formula, H_3CCOCH_3 , represents a(n)
 (A) aldehyde. (B) ester.
 (C) ether. (D) ketone.
56. Which suffix is used to designate a carbohydrate?
 (A) -ase (B) -ate (C) -one (D) -ose
57. Which compound has the largest molar mass?
 (A) hexane (B) 1-hexene
 (C) 1-hexyne (D) benzene

58. Which functional group is not commonly found in proteins?

- (A) alcohol (B) aldehyde
(C) amide (D) amine

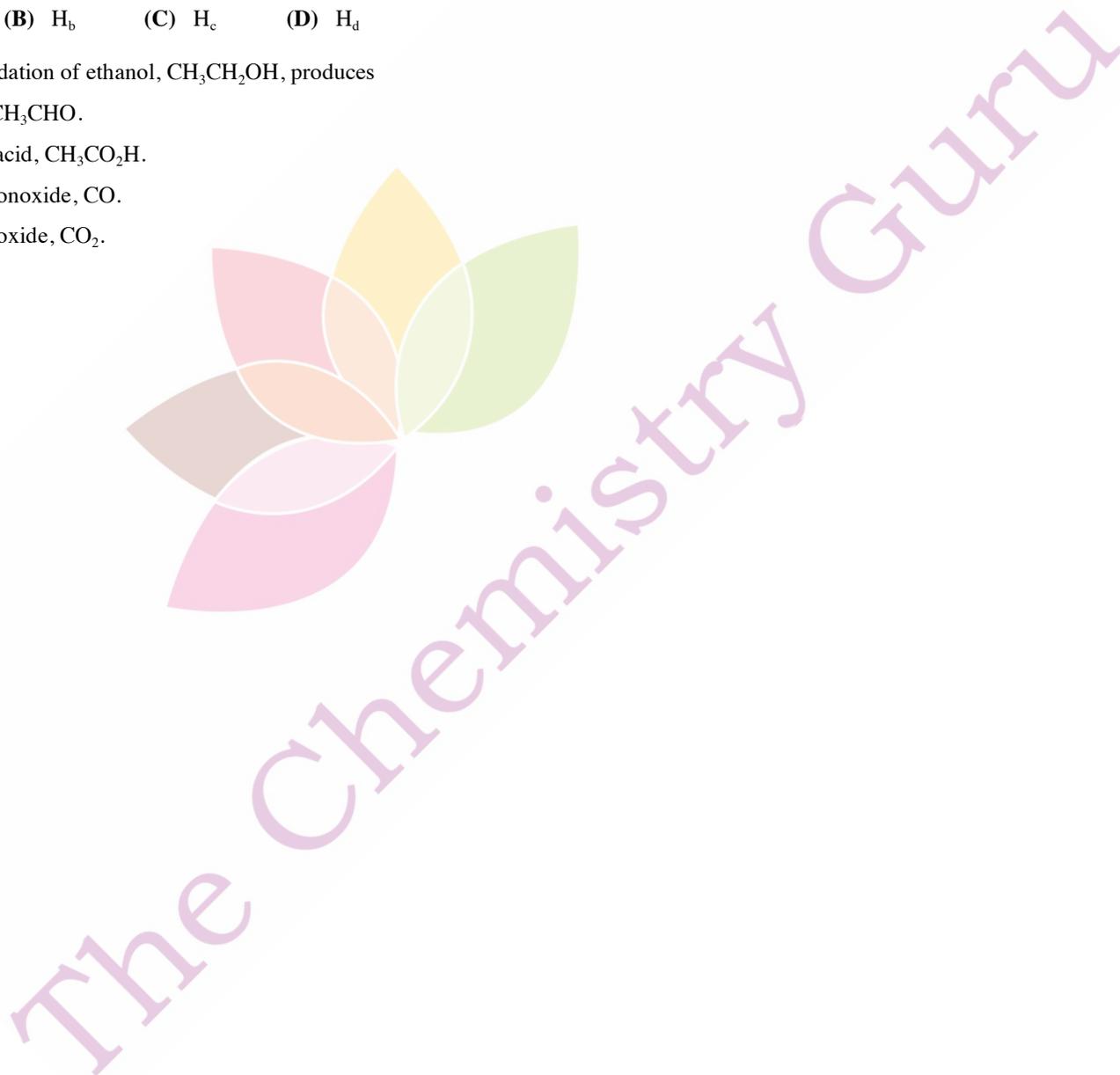
59. Which hydrogen is the most acidic in the molecule shown?



- (A) H_a (B) H_b (C) H_c (D) H_d

60. The gentle oxidation of ethanol, CH_3CH_2OH , produces

- (A) ethanal, CH_3CHO .
(B) ethanoic acid, CH_3CO_2H .
(C) carbon monoxide, CO .
(D) carbon dioxide, CO_2 .



KEY

Number	Answer	Number	Answer
1.	B	31.	C
2.	D	32.	C
3.	C	33.	A
4.	A	34.	B
5.	B	35.	D
6.	A	36.	C
7.	B	37.	C
8.	C	38.	D
9.	C	39.	A
10.	D	40.	B
11.	B	41.	A
12.	A	42.	D
13.	B	43.	B
14.	D	44.	A
15.	A	45.	C
16.	A	46.	B
17.	D	47.	D
18.	C	48.	D
19.	C	49.	C
20.	B	50.	A
21.	D	51.	D
22.	D	52.	C
23.	C	53.	B
24.	A	54.	C
25.	C	55.	D
26.	A	56.	D
27.	B	57.	A
28.	D	58.	B
29.	C	59.	D
30.	A	60.	A